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On behalf of the MooDFOOD Prevention Trial Investigators

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Effects of food-related behavioral activation therapy on eating styles, diet quality and body weight change: Results from the MooDFOOD Randomized Clinical Trial

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ABSTRACT

Objective: Depression and obesity are bi-directionally related, eating styles and diet quality are two important factors associated with both. It remains uncertain if and how these two factors can be modified. Therefore the current study aims to investigate whether food-related behavioral activation therapy (F-BA), targeting mood, dietary habits and food related behavior, can improve eating styles, and diet quality and reduce body weight in adults with overweight or obesity and subsyndromal depressive symptoms.

Methods: Data were derived from the MooDFOOD prevention trial, a 2x2 factorial RCT investigating the effect of nutritional strategies on prevention of depression. Changes in emotional, uncontrolled, and cognitive restrained eating (Three Factor Eating Questionnaire Revised), Mediterranean Diet Score (MDS), and body weight were analyzed among 1025 adults who either received F-BA or no intervention for 12 months. Intervention effect was tested by longitudinal analysis of covariance using mixed model analysis.

Results: The F-BA group showed a small decrease in emotional ($\beta = -5.68$, $p < .001$) and uncontrolled eating ($\beta = -4.05$, $p = .03$), and increase in cognitive restrained eating ($\beta = 5.53$, $p < .01$), compared to no F-BA. The effect of the F-BA therapy on emotional and uncontrolled eating was stronger in those with higher baseline depressive symptoms (IDS-SR). The F-BA did also lead to small improvements in MDS ($\beta = 1.95$, $p < .001$), but not to change in body weight.

Conclusion: Our trial showed no reduction in bodyweight, but provides support for the possibility to improve both unhealthy eating styles and diet quality using an intervention targeting these specifically, although effects were small [Trial registration: clinicaltrials.gov NCT02529423].

1. Introduction

Psychological eating styles constitute one factor that has been suggested to account for individual differences in the susceptibility to gaining weight in the current obesogenic environment of modern societies. Eating styles refer to a complex interplay amongst physiological, psychological, social, and genetic factors that influence food preferences and quantity of food intake [1]. Most research in the past decades focus on three specific different eating styles, based on three psychological theories. Eating to regulate emotions (emotional eating; e.g. "When I feel blue I often overeat"), eating in response to exposure to attractive food (uncontrolled eating; "I am always hungry enough to eat at any time") and cognitive eating control (cognitive restrained eating; e.g. "I consciously hold back at meals in order not to gain weight") have been shown to be related to weight loss treatment outcomes [2–5].

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Previous studies showed that individuals with high levels of emotional [2,3] and uncontrolled eating [4,5] typically have less dietary success and lose less weight in weight reduction treatment programs. Reductions in emotional and uncontrolled eating, and increase in cognitive restrained eating are associated with increased weight loss during these treatment programs [3,6–10]. In addition, cross-sectional associations between unhealthy eating styles and poor diet quality have been found [11–20].

Recent evidence suggests that different kinds of psychological treatments (e.g. mindfulness-based treatment (MBT), acceptance and commitment therapy (ACT), behavioral therapy (BT)) specifically focusing on eating styles show promising results changing maladaptive eating styles. For emotional eating, BT or ACT interventions showed positive results [7–9,21,22], while MBT interventions did not show beneficial effects. For uncontrolled eating, two out of three MBT interventions aimed at changing eating styles were effective [21,23], while the only one MBT intervention that focused directly on changing cognitive restrained eating failed to find an effect [21]. In addition, studies show that most general weight loss interventions seem to be successful in changing some, but not all of the three eating styles [3,6,10,24]. Overall, as findings of different studies were mixed, studies showed large methodological differences and the majority of the studies were not carried out as randomized controlled trials, uncertainty remains. Continued efforts need to focus on developing treatment strategies that have a sizable impact on unhealthy eating styles. In addition, it would be relevant to study whether the impact of intervention strategies on eating styles would differ across specific groups (males vs. females, and overweight/obesity levels).

The MooDFOOD randomized controlled trial aimed to investigate the effectiveness of person-tailored food related behavioral activation (F-BA), which included changing eating styles and improving diet quality, on incident depression. In a large group of overweight and obese European citizens with subthreshold depressive symptoms, the F-BA therapy provided nutritional advice towards better adherence to a Mediterranean style diet, and focused on changing primarily dietary habitual behaviors including all three unhealthy eating styles (emotional eating, uncontrolled eating, cognitive restrained eating) [25]. The primary trial results showed that the F-BA therapy was not successful in reducing episodes of major depressive disorder during one year [25,26]. In this current, secondary exploratory data analysis, we aim to investigate whether the F-BA therapy could 1) modify three unhealthy eating styles: emotional eating, uncontrolled eating and cognitive restrained eating, and 2) increase diet quality. Furthermore, we also investigated the effect of F-BA on a possible reduction in body weight. Body weight was considered a posthoc outcome because the therapy was not primarily designed to cause weight loss, and body weight was therefore not listed among the secondary outcomes of the MooDFOOD trial but as potential mediator. . However, we consider body weight a relevant post-hoc outcome given the established relationships between diet and depression, where intervention-induced improvements in mood could result in a healthier lifestyle, which could subsequently lead to reduction in body weight in this overweight/obese population.We also investigated in secondary analyses whether the F-BA therapy effect on eating styles, diet quality and body weight was moderated by sex, baseline depression and BMI level.

2. Methods

2.1. Study design and sample

Data of the MooDFOOD (Multi-country cOllaborative project on the role of Diet, Food-related behavior, and Obesity in the prevention of Depression) prevention study were used. The MooDFOOD prevention study is a 2x2 factorial randomized controlled trial (RCT), performed between July 30, 2015, and October 13, 2017, and its primary objective is to examine the feasibility and effectiveness of two different nutritional strategies to prevent a new episode of major depressive disorder in high-risk overweight persons with subsyndromal symptoms of depression. The primary outcome was the 12-month cumulative onset of an episode of MDD. A detailed description of the MooDFOOD study design, methods and results for the primary outcome can be found elsewhere [25,26]. This prevention trial recruited a total of 1025 subjects in four different European countries (Germany, Spain, The Netherlands and United Kingdom). Participants were randomized to one of four trial arms according to a 2 x 2 factorial design: 1) multi-nutrient supplement with F-BA intervention, 2) placebo supplement with F-BA intervention, 3) multi-nutrient supplement without F-BA intervention or 4) placebo supplement without F-BA intervention (block sizes ranging from 8-12; https://www.sealedenvelope.com) . Randomization was stratified according to recruitment site (i.e. country) and participants' history of depression status at the baseline assessment. After randomization, researchers dispensed supplements to participants according to unique randomization codes. Participants and therapists, and researchers were blinded to supplement allocation, researchers were also blinded to F-BA allocation. The four trial arms were condensed to two arms to make comparisons between participants who received the F-BA intervention (F-BA group) and participants who did not receive the F-BA intervention (control group). We assume that the multi-nutrient supplement has a null effect on eating styles and thus is not studied in this paper, but analyses were adjusted for multi-nutrient supplement use. For full details of trial design and protocol see Roca et al. [25] For any adverse events and concealment, see Bot et al. [26].

Participants were recruited via diverse strategies, including websites; local advertisements in social media and newspapers; mailings to registered subjects in the general practice setting or in other registers (e.g. city registers); and MooDFOOD brochures and posters in public areas. Participants were recruited in both urban and rural municipalities. Inclusion criteria were being aged 18 to 75 years old, being overweight or obese (body mass index (BMI) between 25–40 kg/m^2) and reporting subsyndromal symptoms of depression as operationalized by the Patient Health Questionnaire (PHQ-9) score of at least 5 [27]. The research protocol was approved by the Ethical Committees of the contributing countries and all participants provided written informed consent. All eligible participants were invited to visit one of the study sites for a baseline interview, physical measurements, and blood sampling conducted by trained research assistants/nurses, and the completion of self-report questionnaires. Follow-up assessments took place at 3, 6 and 12 months, and included measures of eating styles, body weight, and food intake (for 6 and 12 months).

2.2. Food-related behavioural activation therapy (F-BA)

F-BA consisted of a protocol-based intervention incorporating standard BA approaches proven effective in depression treatment [28], including self-monitoring, functional analysis, and activity scheduling, with a focus on changing dietary habits and emphasizing a Mediterranean-style diet, to reduce the risk of clinical depression. F-BA was provided in up to 21 sessions (15 individual, 6 group) for one year. The individual sessions were provided in single 30-minute or double 1-hour meetings occurring at first weekly and then every two weeks, while the subsequent group sessions included up to 10 people and lasted about 1 hour, occurring at first monthly and then bimonthly. Among the 512 participants randomized to the F-BA group, 71% attended at least 8 out of the 21 sessions. Participants attended a median of 14 out of 15 individual sessions (interquartile range (IQR) 6-15) and a median of 0 out of 6 group sessions (IQR 0-4) [26]. The control group received no F-BA intervention (n = 513 participants).

The intervention developed specifically for this study using the combined expertise within the consortium including from psychological treatment researchers and nutritionists, i.e., an expert group in the team. The core elements of the intervention followed the key principles of behavioural activation with respect to changing behaviour with a

focus on self-monitoring, activity scheduling and functional analysis, following the contextual approach to behavioural activation [29,30] and incorporating models of habit change such as identifying and removing triggering cues to habits, learning and rehearsing new responses [31], and the use of If-Then plans [32–34]. This therapeutic approach has already been instantiated in two existing variants of BA that have been proven to be effective in clinical trials for patients with depression [35,36]. The original focus of BA on mood-related behaviours such as approach, avoidance and rumination was retained but also expanded to include a focus on increasing healthy food-related behaviours (e.g., regular meal-times; eating a Mediterranean diet) and to decrease unhealthy food-related behaviours (e.g., snacking, emotional eating [37]. There was an emphasis on changing habits around food because habit is one of the most powerful predictors of eating behaviour [38], and patterns of eating behaviour may also be linked to emotional state, such as comfort eating and emotional eating, which may in turn lead to cycles of weight gain and depression [39]. A trial manual could be made available on request.

The F-BA intervention focused on changing food-related behaviors and shifting habitual eating patterns to improve diet in order to prevent the onset of depressive episodes. It focuses on reducing avoidant behaviors and building routines and behaviors that are rewarding and/or pleasant, proven effective in the treatment of depression [40]. Modifying body weight was not a central goal of the program. Psychologists familiar with behavioral activation were trained and delivered the F-BA intervention. The psychologists helped the participant to set goals regarding the introduction of healthy food (described in the next section) as well as to reduce the intake of foods considered to be eaten in excess, taking into account baseline records. Goals were revisited and modified when necessary during subsequent sessions. During the intervention participants kept a record of daily activities and habits, and were able to take notes about their mood and foods eaten during the day. The records aimed to help in the identification of triggers to habits and engagement in self-monitoring to improve food-related behaviors (e.g. regular meals per day, less snacking) and habitual eating patterns (e.g. decrease emotional eating). The participants were provided with a participant manual with detailed information about what was discussed.

An introduction to healthy eating associated with mood improvement was provided in the third therapy session (two weeks after the first F-BA session), which involved the provision of dietary guidelines based on a Mediterranean-style dietary pattern, referred to as the MooDFOOD dietary guidelines. The MooDFOOD dietary guidelines were based on a Mediterranean-style diet as this diet has shown to be related to reduced depression onset [41] . The dietary guidelines in this study are consistent with those presented in the updated Mediterranean diet pyramid [42] except for low-fat dairy (3 versus 2 servings/day).

2.3. Eating styles measurement

The three unhealthy eating style scales of the shortened and revised 18-item Three Factor Eating Questionnaire (TFEQ-R18) [43] were used to assess self-reported emotional, uncontrolled and restrained eating at baseline, 3, 6 and 12 months follow up. The TFEQ-R18 was developed on the basis of factor analyses of the original 51-item TFEQ [44] in a large sample of obese subjects [43], and has also been found to be applicable to the general population [11]. The emotional eating scale consists of three items, e.g., “When I feel blue I often overeat”, the uncontrolled eating scale includes nine items, e.g. “I am always hungry enough to eat at any time”, and the cognitive restrained eating scale consists of six items, e.g., “I consciously hold back at meals in order not to gain weight” [11]. Thirteen of the items are rated on a four-point scale from 1, does not describe me at all, to 4, describes me exactly, four have other 4-point scale answers and one question is measured on an 8-point scale (from 1, no restraint in eating, to 8, total restraint). Following precedent, [11], raw scale scores are transformed to a 0–100 scale (((raw score - lowest possible raw score)/possible raw score range)) * 100). The baseline Cronbach’s alphas for the current study were 0.82, 0.89 and 0.73 for emotional eating, uncontrolled eating, and cognitive restrained eating, respectively.

2.4. Dietary intake

Participants reported their usual food intake during the previous month by completing an online self-administered Food Frequency Questionnaire (FFQ) at baseline (T0), six months (T6) and at 12 months (T12; end of trial). The FFQ consisted of the validated GA2LEN FFQ as it showed to be an appropriate tool to estimate dietary intake across Europe regardless of cultural and linguistic differences [45]. The FFQ included 210 food items which were categorized into 18 food groups based on food groups for which dietary recommendations were made in the F-BA intervention: 1. vegetables, 2. fruit, 3. fish, 4. meat, 5. egg/soy, 6. pulses/legumes, 7. nuts, 8. potatoes, 9. whole grains, 10. refined grains, 11. low-fat dairy products, 12. high-fat dairy products, 13. olive oil, 14. other fats/oils, 15. sweets/extras, 16. soft drinks, 17. alcoholic beverages, 18. water/coffee/tea. Standard portion sizes following the Food Standard Agency Food Portion Sizes Guidelines were used [46]. Dietary intake was considered missing if > 15% of the FFQ was incomplete or if energy intake was under-/over-reported [47]. Energy over-/under-reporting was classified as an energy intake spanning above or under the mean plus/minus three standard deviations. Diet quality was measured with the Mediterranean diet score (MDS) ranging from 0 to 55, which was is developed by Panagiotakos et al. [48]. A higher score implies a higher adherence to the Mediterranean diet. The MDS includes 11 food components (non-refined grains, potatoes, fruits, vegetables, legumes, fish, red and processed meat, poultry, full fat dairy products, olive oil and alcohol). For each component, a score between 0 to 5 points could be obtained, following the scoring algorithm as reported in the paper of Panagiotakos [48].

2.5. Other measurements

Sex, age, and education level were assessed in the baseline interview. Good compliance to interventions (attending ≥8 of 21 F-BA sessions) was defined a priori [26]. Body weight and body height were measured by a trained research assistant at each visit. BMI was calculated as weight kilograms divided by height squared in meters (kg/m^2). Weight change was calculated using absolute changes in weight (kg). At baseline, presence of a lifetime history of major depressive disorder was established using the MINI 5.0 [49]. All participants were classified as either not having or having a lifetime diagnosis of major depressive disorder. Severity of depressive symptoms was assessed with the Inventory of Depressive Symptomatology- Self Rated (IDS30-SR [50]). This was reported at baseline, and during the follow-up assessments.

2.6. Sample size

As described in detail elsewhere [25,26], the sample size calculation of the MooDFOOD prevention trial was based on the primary dichotomous outcome (MDD).

2.7. Statistical analyses

Primary analyses were based on the intention-to-treat principle. Descriptives of the baseline characteristics were provided for the sociodemographics, health variables and eating styles.

To conduct the main analyses with complete data, first, multiple imputation was performed. Among the 1,025 participants randomized to the MooDFOOD depression prevention trial, 87 had missing dietary intake data, eating style data or weight data at T0, 186 participants had missing data at all follow-up measurements due to > 15% missing data on the FFQ, not completing the TFEQ or because of missing weight

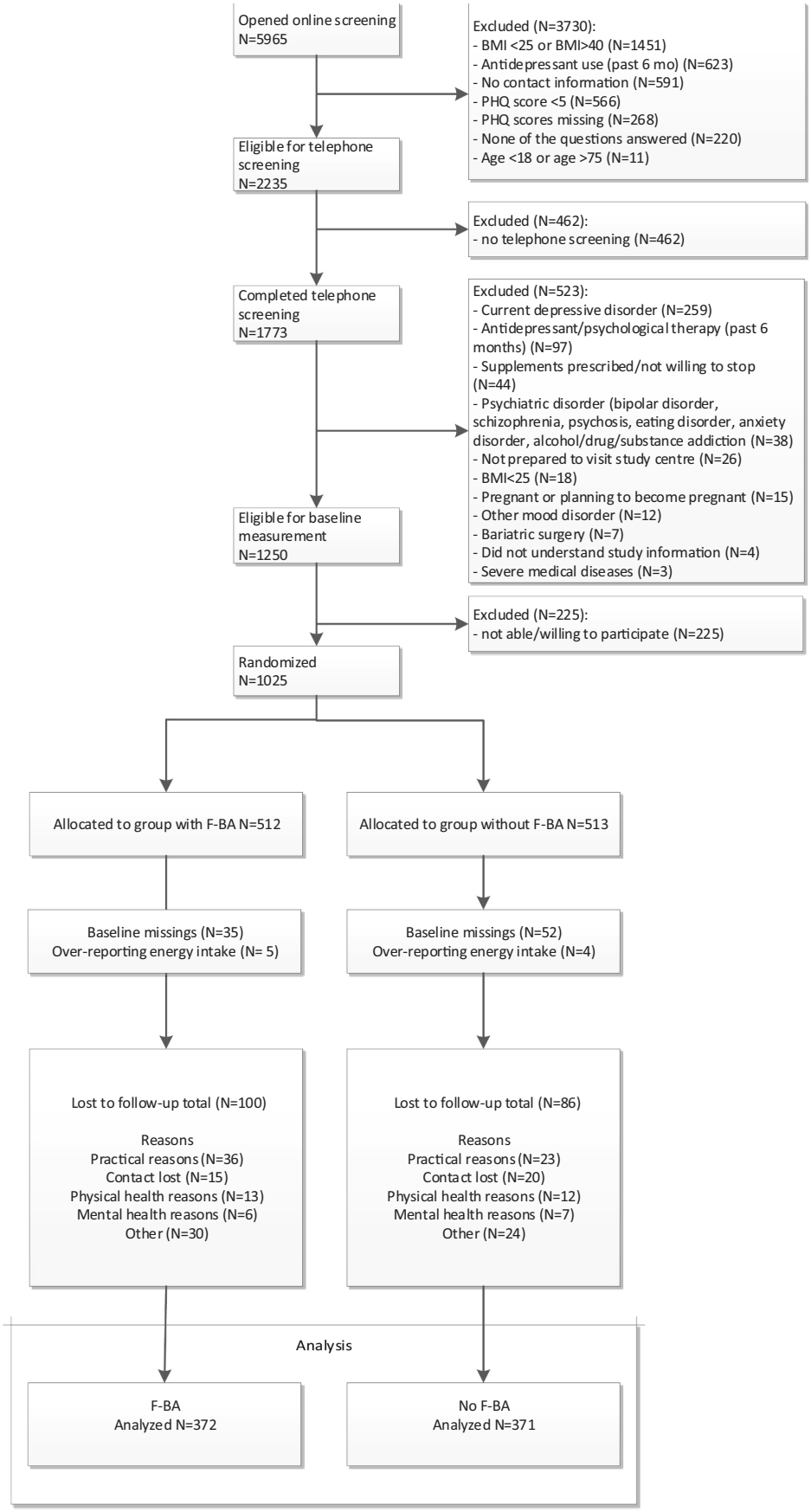

Fig. 1. Flow of Participants Through the MooDFOOD Depression Prevention Trial.

measurements. Additionally, FFQ information of 9 participants was set to missing due to over-reporting energy intake at either T0 or at both T6 and T12 (See Figure 1). All missing values were qualified as missing at random. With use of the SPSS multiple imputation procedure, 5 imputations were obtained as this should give an efficiency of 99% compared to using an infinite number of imputations (53). Variables which were non-normally distributed were log transformed before being entered in the multiple imputation, and back transformed afterwards. Consistent with the guidelines for variable selection for multiple imputation as described by Sterne et al. [51], the following variables of all the assessments were included in the multiple imputation procedure: age, sex, site, years of education, ethnicity, BMI and weight, cigarette and alcohol use, depression history and severity, the three eating styles and MDS score.

To investigate the primary outcome, whether the F-BA therapy could modify three unhealthy eating styles, longitudinal analysis of covariance using mixed model analyses (LMM) were performed through a marginal model. This way, the difference in eating styles between the F-BA and control group could be evaluated [52]. Interactions with time were added to the models, to study whether therapy effects became stronger over time. Effect sizes were estimated calculating a Cohen's D from baseline and 12-month follow-up means, and pooled pre-test standard deviations [53]. Effect sizes were defined as small, medium, and large (d = .2, .5, and .8, respectively) [54].

As post-hoc analyses, to investigate whether effects of the F-BA therapy on eating styles differed for different subgroups of participants, it was examined whether there was an interaction effect of sex, continuous baseline depressive symptoms (IDS-SR 30) or continuous baseline BMI by adding interaction terms of these variables*eating styles to the LMM model.

To investigate whether the F-BA therapy also led to changes in diet quality and body weight, LMM analyses were conducted for these variables.. Finally, analyses on the complete cases were done as sensitivity analysis.

All analyses were adjusted for history of depression, nutrient supplement intervention (active /placebo). age, sex and site. In addition analyses were adjusted for baseline values of emotional eating, uncontrolled eating, cognitive restrained eating, MDS score and weight in the respective analysis (e.g. adjustment for baseline emotional eating in analyses with emotional eating as outcome). Statistical analyses were conducted with SPSS, version 22 (IBM Corp, Armonk, N.Y.) For all statistical tests the significance threshold was set at 0.05.

3. Results

Among the 1,025 participants randomized in the MooDFOOD depression prevention trial, 743 participants had complete available data to be included in the analyses, while 282 participants had missing data. Baseline differences between participants with complete and missing data can be found in Supplementary Table 1.

Baseline characteristics of the F-BA and control groups are presented in Table 1. Participant's mean age was 47.5 y, and overall similar characteristics were found between the 2 groups. The F-BA group, as compared to the control group, contained relatively more females, and obtained somewhat lower scores on uncontrolled eating, and higher scores on cognitive restrained eating and MDS.

Over the total 12-month period, the F-BA group showed a decrease in emotional (β = -5.68, 95% confidence interval (CI)= -8.27; -3.09, $p < .001$) and uncontrolled eating (β = -4.05, 95% CI = -7.65; -0.45, $p = .03$), relative to the control group (Figure 2; Supplementary table 2 and 3). In addition, increases in cognitive restrained eating (β = 5.53, 95% CI = 2.33; 8.74, $p < .01$) were found in the F-BA-group relative to the control group. An interaction with time was found for emotional eating only, this indicates that the effect of the F-BA therapy strengthens over the 12 months. For all three eating styles, effect sizes were small (Cohen's D = -0.043 - 0.239; Supplementary table 3)

Hereafter, as post-hoc analyses, it was investigated whether the F-BA effects differed between several subgroups of participants. Hence, interaction terms of sex, baseline depressive symptoms (IDS-SR 30) and BMI were entered to the models separately. No statistically significant interactions with sex or BMI were found ($p > .05$ for all analyses). For emotional eating and uncontrolled eating, a statistically significant

Table 1
Baseline sample characteristics for complete cases of the MooDFOOD prevention trial (N = 743)

	F-BA group (N = 372)	Control group (N = 371)	Total group
Demographics			
Age (mean, sd)	47.8 (12.6)	47.3 (13.4)	47.5 (13.0)
Sex (%, female)	78.2	72.5	75.4
Level of education (%)			
Lower education	8.3	10.8	9.6
Middle education	47.6	46.9	47.2
Higher education	44.1	42.3	43.2
Site (%)			
Germany	28.0	31.8	30.4
United Kingdom	24.2	25.3	24.7
Spain	20.4	22.1	21.3
The Netherlands	26.7	20.8	23.6
Supplements (%)			
Multi-nutrient supplement	47.3	49.1	48.2
Placebo	52.7	50.9	51.8
BMI (mean, sd)	31.2 (3.8)	31.2 (4.1)	31.2 (4.0)
Psychiatric characteristics			
History of depression (%, yes)	31.2	33.4	32.3
Severity of depressive symptoms IDS-30 SR (mean, sd)	20.8 (9.8)	21.9 (9.9)	21.3 (9.9)
Psychological eating styles			
Emotional eating (mean, sd)	55.3 (30.0)	55.9(31.4)	55.6 (30.7)
Uncontrolled eating (mean, sd)	47.9 (23.5)	50.6 (22.5)	49.3 (23.0)
Cognitive restrained eating (mean, sd)	42.6 (19.8)	41.9 (19.9)	42.2 (19.8)
Mediterranean Diet Score	30.3 (4.5)	29.6 (4.9)	30.0 (4.7)
IDS-30 SR: Inventory of Depressive Symptomatology 30 item version, self-report			

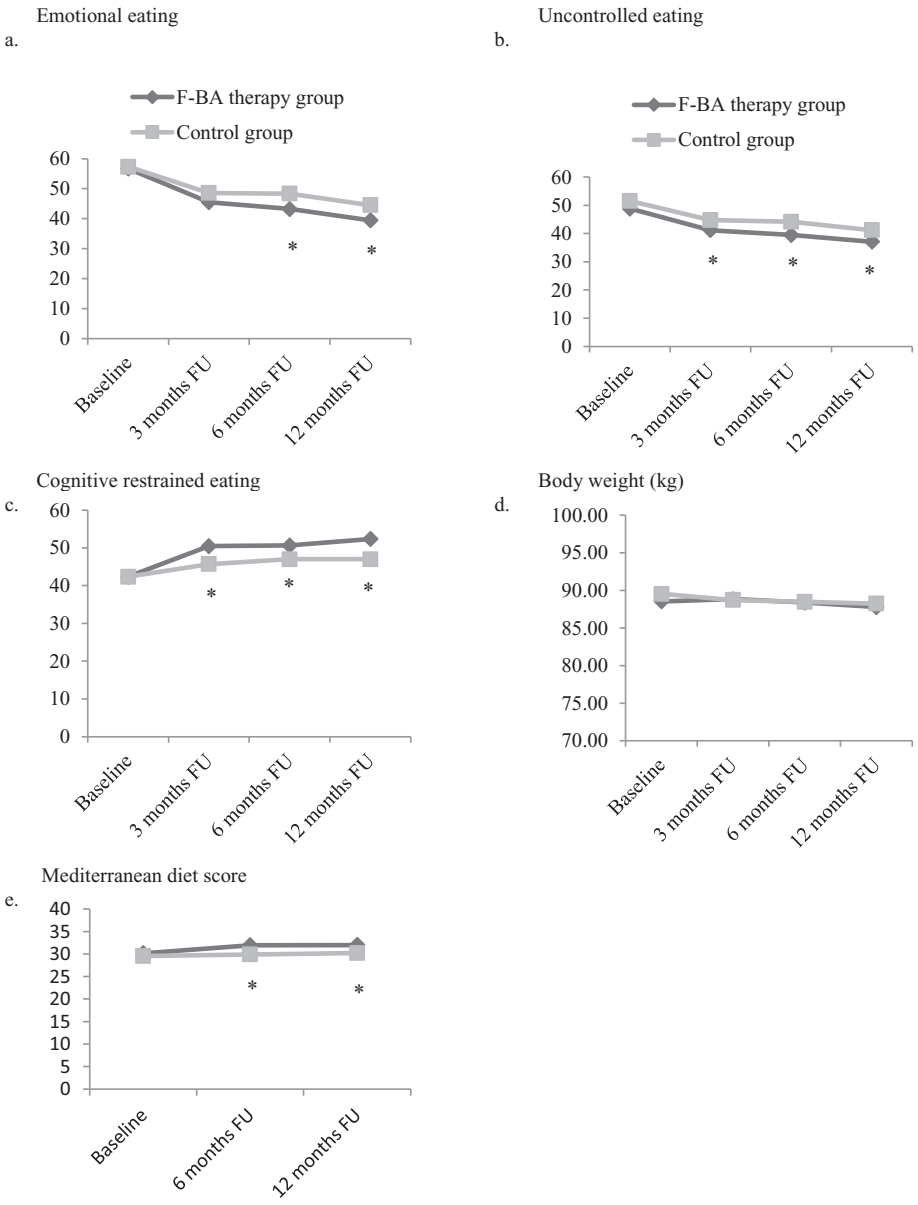

Fig. 2. Changes in eating styles and body weight from baseline to 12 months follow-up between participants who received food-related behavioral activation therapy (F-BA group) and participants who did not receive food-related behavioral activation therapy (control group), N = 1025.
Adjusted means are presented. Corrected for site, history of depression, supplement use, and baseline values emotional eating, uncontrolled eating, cognitive restrained eating, MDS score and weight in the respective analysis.
* = significant differences ($p < 0.05$) between F-BA group and controls on outcome measure

interaction with depressive symptoms was found (emotional eating: β interaction term = -0.39, p = .001; uncontrolled eating: β interaction term = -0.21, p = .02), indicating that the effect of F-BA on emotional eating was larger in those with higher baseline depressive symptoms. Only 2 out of 9 interactions were shown to be statistically significant,. For completeness, Supplementary Table 4 shows LMM analyses stratified for high versus low baseline depressive symptoms (median split, median = 21). Results showed a stronger effect of the F-BA therapy on emotional and uncontrolled eating in those with higher depressive symptoms only. For weight change, a statistically significant interaction was found with depressive symptoms (β interaction term = -0.09, p = .03), however stratified analyses showed no statistically significant effects of F-BA on weight change in those with low depressive symptoms (b = 0.66,p = .30) and high depressive symptoms (b = -0.20,p = .76). For MDS scores, no statistically significant interactions were found for sex, BMI or depression.

To investigate whether the F-BA therapy led to changes in diet quality and body weight, LMM analyses were performed. Results showed an increase in MDS (β = 1.95, 95% CI = 1.39; 2.51, p < .001) over 12 months in the F-BA group relative to the control group, with a small effect size of Cohen's D = 0.234 (Figure 1, Supplementary table 2 and 3). For MDS, no interaction with time was found. No differences in body weight were observed between the F-BA and no F-BA group after 12 months.

Sensitivity analyses showed that results of analyses with the complete cases are in line with the analyses done in the multiple imputed sample (Supplementary Table 5)

4. Discussion

Using a large group of overweight and obese individuals with subsyndromal depressive symptoms, the current exploratory study showed

that the food-related behavioral activation (F-BA) therapy was able to successfully modify three psychological eating styles. During the 12-month trial, both self-reported emotional and uncontrolled eating was reduced, while self-reported cognitive restrained eating increased during the trial. In addition, the F-BA therapy did improve diet quality. Stratified results showed that the effect of the F-BA therapy on emotional and uncontrolled eating was stronger in those with higher depressive symptoms. No effect of the F-BA therapy on body weight change was found.

The current results support earlier studies that already showed eating styles could be modified using mindfulness based treatments (MBT), acceptance and commitment therapy (ACT), and behavioral therapy (BT) [7–9,21–23]. Results for emotional eating also showed there to be an interaction with time, this indicates that the effect of the F-BA therapy strengthens over the 12 months. In the current study, changes in emotional and uncontrolled eating were small and indicated little clinical relevance, however as the TFEQ is specifically developed for research, no normative data or cut-off scores are known. In addition, comparing the current changes in eating styles with earlier studies is difficult as other studies use different versions of the TFEQ, or do not report the magnitude of changes.

In addition to change in eating styles, the current study also shows the F-BA therapy to be successful in improving diet quality. However, as the improvement is only 1.7 points on a range of 0-55, the clinical relevance seems fairly low. To the best of our knowledge, there are no other trials on improving diet quality using the current MDS score, making direct comparison difficult. In general, an increased adherence to a Mediterranean dietary pattern of 1 standard deviation (SD) is associated with lower risks of cardiovascular disease, mortality, and cancer [55,56]. As the current SD is 4.5, this is another indication that the effect on MDS, although statistically significant, has limited clinical relevance.

Interestingly, in the current study the effect of the F-BA therapy on eating styles seems to be stronger in participants with higher current depressive symptoms. As the current study included a unique group of participants, this finding cannot be compared with earlier research. Results show that in the current sample those with high depressive symptoms also have the most unhealthy eating styles (data not shown), this is in accordance with earlier studies from our research group that showed in the current and other samples associations between depression and unhealthy eating styles [57,58]. Thereby, in this group the room for improvement in eating styles was the largest. Those with more severe subsyndromal depression were possibly more motivated to change unhealthy habits and thereby work their way to improved mood than those with less severe subsyndromal depression. However, these results should be interpreted with caution given the many interaction tests done.

Results of the current study showed that the F-BA therapy did not cause changes in body weight. This is not in accordance with earlier studies. Results showed that both BT, ACT and general weight loss interventions were not only successful in lowering body weight, but also demonstrated this change to be accompanied by change in eating styles [3,7,8,10]. A likely explanation for not finding reductions in body weight in the current sample, is the focus of the F-BA intervention. The present intervention was not intended to promote weight loss, but aimed to improve mood by changing dietary habits, food-related behaviors (e.g., emotional eating), increasing positive behaviors, and emphasized a Mediterranean-style diet. This is in contrast to the earlier studied BT, ACT and general weight loss interventions that specifically aimed at losing weight.

The current study has important strengths. It used a randomized 2 × 2 factorial design, investigated new tailored intervention aimed at changing food related behavior, and had a relatively long follow-up period of 1 year. Also, the current study included a large group of participants from four countries, with different background characteristics and dietary patterns. However, this study also suffers from some limitations. First, a considerable number of participants (about a quarter) were lost to follow-up. Although this number was balanced between intervention groups, and is fairly common to drop-out in other prevention trials, attrition bias cannot be ruled out [26]. Second, as the follow-up time of this study was set to 1 year, it cannot be ruled out that extended follow-up measurements could have detected more or other effects of the therapy. Third, the study population was overweight and at high risk of depression, limiting the generalizability of our findings to other populations. Yet this population was also a strength of this study as there was room for improvement in the eating styles, diet and weight, allowing us to observe change in a 12-month time period. Fourth, changes in eating styles and diet quality were small, with limited clinical relevance. Finally, the F-BA intervention was not blinded. F-BA participants might be more prone to report their dietary habits in a more positive way during the intervention and therefore reported healthier eating styles and better diet quality.

To conclude, the current exploratory study showed that among overweight or obese adults with subsyndromal depressive symptoms, the food-related behavioral activation therapy was effective in improving psychological eating styles. In addition, the F-BA therapy was also successful in improving diet quality, although both effects were small. No effects on body weight were found in the current study indicating that the F-BA used in the current study is not an adequate intervention for reducing weight in this overweight population. Further studies need to examine how to increase and expand the current therapy effects from improving both unhealthy eating styles and diet quality to also facilitating weight loss. The challenge is thus set upon interventionists to devise programs that most effectively target and change these interrelated factors.

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Declaration of Competing Interest

NPGP, MB, IAB, MV, MG, EK, MO and EW have no financial or conflicting interests to disclose. MR reported receiving grants from the European Union and research funding from Janssen and Lundbeck outside the submitted work. BWJHP reported receiving grants from Janssen Research and Boehringer Ingelheim outside the submitted work. UH reported receiving personal fees from Lundbeck, Janssen Pharmaceutica, Servier, Bayer Pharma, and Medice outside the submitted work.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychores.2020.110206.

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